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APPLICATION

FOR

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TITLE: RAIL BASED ELECTRIC POWER DISTRIBUTION NETWORK

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RAIL BASED ELECTRIC POWER DISTRIBUTION NETWORK

FIELD OF THE INVENTION

[0001] The present invention relates generally to rail vehicles, and more particularly to trains including mobile power distribution networks.

BACKGROUND OF THE INVENTION

[0002] In today's world electricity is required nearly everywhere. In many mobile transport vehicles electricity is used to power auxiliary equipment such as air conditioners, lighting and heaters. Rail based vehicles, such as trains moved by diesel or similar locomotives, for example, typically include an electric generator that generates electricity that is distributed by way of a modular distribution network to cars on the train.

[0003] In such an environment, electricity is generated on the moving vehicle and distributed by way of a mobile distribution network. At each electricity consuming car, electricity is tapped and consumed.

[0004] Because such a distribution network is modular, and electric power is consumed at many locations, faults are difficult to locate. In conventional trains such faults are located by elimination. The fault is initially detected at the generator. After its detection, cars are systematically disconnected from the mobile network until the location of the fault is isolated. This, however, is time consuming and labour intensive.

[0005] Clearly then, there is a need for a method of detecting a fault on a rail transport vehicle having a modular electric distribution system, and an improved rail transport vehicle allowing easy electric fault detection on an associated distribution network.

SUMMARY OF THE INVENTION

[0006] In accordance with the present invention multi-phase electric power is distributed in a train. The train includes a plurality of cars, each of which includes a wiring harness for interconnection to an adjacent car to distribute multi-phase electric power. The method includes generating the multiphase electric power; providing the multiphase electric power to a power distribution network formed of a plurality of such wiring harnesses; tapping multiphase power from the power distribution network at at least one of the cars for consumption at the at least one of the cars; sensing net current tapped at the at least one of the cars; and triggering an alarm if the net current tapped at the at least one of the cars does not equal zero, signifying a ground fault at the at least one car.

[0007] A train exemplary of the invention includes, a locomotive; a plurality of cars; a multi-phase electric generator; an electrical distribution network extending from the electric generator to the plurality of cars; at least one of the cars comprising a power providing conductors for providing multi-phase electric power to an electric load on the car; and a ground fault sensor interconnected with the power providing conductors for sensing and indicating a ground fault at the at least one of the cars.

[0008] Other aspects and features of the present invention will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] In the figures which illustrate by way of example only, embodiments of the present invention,

[0010] **FIG. 1** is an elevational view of a train including a distribution system exemplary of embodiments of the present invention;

[0011] **FIG. 2** is a top plan view of the train of **FIG. 1**;

[0012] **FIG. 3** is a schematic diagram of portions of the distribution system of **FIG. 1**; and

[0013] **FIG. 4** is a schematic diagram of a ground fault detection circuit, used in the train of **FIG. 1**.

DETAILED DESCRIPTION

[0014] **FIG. 1** illustrates a rail borne vehicle in the form of train **10**, including an electrical distribution network **12**, exemplary of an embodiment of the present invention. As illustrated, train **10** includes a locomotive **18** and a plurality of towed cars **16**. The train **10** may, for example, be a passenger train, with cars **16** suited for passenger transport.

[0015] Locomotive **18** includes a conventional engine (not specifically illustrated) that may, for example, be a diesel engine. In the described embodiment, a generator **14** for generating electricity used to power auxiliary equipment on train **10** is located within locomotive **18**. Electric power generated by generator **14** is distributed throughout train **10** by way of a mobile electric power distribution network **12**.

[0016] Train **10** is illustrated in top plan view in **FIG. 2**. Specifically, distribution network **12** is a three phase distribution network that extends along the top of train **10**. In the disclosed embodiment, distribution network **12** includes a left and right set of three length-wise extending conductors **22a**

and **22b**. Each of the length-wise extending conductors transports one phase of three-phase electric power from generator **14** to each of cars **16**. Network **12** is modular, in that each car includes two sets of three conductor harnesses **24** (a left and right harness), terminated at each end by a connector **26**. Connectors of adjacent cars may be interconnected so that network **12** may extend from the front to the rear of train **10** providing electric power to each car **16**. As new cars are added to train **10**, harnesses **24** of such cars may be interconnected to an existing network **12**.

[0017] In order to limit the power required to be carried by each harness **24**, by each set of conductors **22a** or **22b**, and through connectors **26**, two separate three-phase distribution harnesses **24** are provided on each car **16**. In this way, the total power delivered to each of cars **16** may be delivered by two sets of conductors **22a** and **22b**, each only needing to carry half the current required by a single set of conductors.

[0018] Portions of distribution network **12** and generator **14** are schematically illustrated in **FIG. 3**. As illustrated, generator **14** provides two three-phase feeds, **20a** and **20b**. In the disclosed embodiment, generator **14** is WYE-connected. A centre tap **28** of generator **14** is connected to ground by way of ground-fault limiting impedance **30**. Ground limiting impedance **30** is preferably sufficiently large to limit ground fault current, preferably to 5A or less. The two three phase feeds **20a** and **20b** emanating from generator **14** terminate at connectors **26a** and **26b**, respectively.

[0019] The portion of electric distribution network **10** of a single rail car **16** is similarly schematically depicted in **FIG. 3**. As illustrated, each car is equipped with a left and right harness **24**. Two connectors **26** allow the interconnection of each harness **24** including conductors **22a** or **22b** spanning the length of car **16** to connectors **26** of a harness **24** of an adjacent car **16** or to connectors **26a** and **26b** of locomotive **18**.

[0020] Conductors **22a** and **22b** of each of harnesses **24** extending along the length of the car may be tapped by three-phase power providing conductors **34a** and **34b**. Each of these feeds one of electrical loads **36a** and

36b. Loads **36a** and **36b** may, for example, be heaters, air conditioners, lights, or similar electrical equipment used in rail car **16**.

[0021] In order to limit the current provided to load **36a/36b** by way of power providing conductors **34a** and **34b**, these are preferably fused or fed through circuit breakers. As illustrated, one current limiter **38**, for example in the form of a circuit breaker or fuse, fuses each phase of the provided three-phase power, provided by way of left or right harnesses **24**.

[0022] Additionally, exemplary of an embodiment of the present invention, ground fault detection circuits **32a** and **32b** (individually a ground fault detection circuit **32**) are provided to detect ground faults caused by a load connected by way of power providing conductors **34a** to left harness **24** or by way of power providing conductors **34b** connected to right harness **24**.

[0023] As illustrated in **FIG. 4**, each ground fault detection circuit **32** includes a current sensor **40**, preferably in the form of a current-sensing transformer, and a conventional ground fault relay **42**, in the form of a DGF digital ground fault relay, interconnected in series with a ground fault indicator **44**. Ground fault indicator **44** is preferably a light. The series combination of relay **42** and indicator **44** are connected between a potential source which may for example be tapped from one of the phases of power providing conductors **34a** or **34b**. An identical ground fault detection circuit **32b** is interconnected with tap **24b**.

[0024] In operation, generator **14** generates three-phase electrical power. Generator **14** may be driven by the engine within locomotive **18** or by another suitable locomotive force. In the absence of any ground faults along distribution system **12**, generator **14** will be balanced; that is, the total current provided by the three-phase output of generator **14** will sum to zero. As such, no current will flow through ground fault-limiting resistor **30**. Generated electricity is provided along conductors **22a** and **22b**, with one phase of each the three phases provided along a single conductor. As a result of the electrical interconnection of cars **16**, the generated power is propagated along conductors **22a** and **22b** and along train **10**.

[0025] Within each rail car **16**, power is tapped from conductors **22a** and **22b** by power providing conductors **34a** and **34b**, depicted in **FIG. 3**. In the absence of any ground fault along any power providing conductors **34a** or **34b**, the net current flowing through all three phases of any one set of power providing conductors **34a** and **34b** will also be zero. As a result, the current through sensor **40** of each ground fault detection circuit **32** will be zero.

[0026] In the presence of a ground fault anywhere along network **12**, generator **14** will become unbalanced and a current reflecting the ground fault will flow through ground fault resistor **30**. Conventionally, such a ground fault may be difficult to locate or isolate. Advantageously, ground fault in any of car **16** results in detection of the ground fault at power providing conductors **34a** or **34b**, as the net current flowing through an associated sensor **40** of ground fault-detection circuit **32a** or **32b** will no longer be zero.

[0027] As a result, current through sensor **40** will trip the associated ground fault relay **42** causing it to close. In response, the associated ground fault indicator **44** will be illuminated. As each car **16** includes a separate ground fault detection circuit **32** for each of its power providing conductors **34a** or **34b**, a ground fault may be easily located and isolated.

[0028] Preferably, two ground fault indicators **44** (one for the right load, the other for the left load) are located in the panel box of each car. In the presence of a ground fault, an operator may simply inspect the ground fault indicator **44** on each car, thereby allowing for quick detection and location of a ground fault. Complex isolation of ground faults on train **10** is no longer required.

[0029] As should be appreciated, multiple ground fault indicators **44** could be replaced remotely located at a single location. Remotely located ground fault indicators could be signalled through a suitable wired or wireless communications network. Optionally, ground faults could be logged using general purpose computing equipment suitably adapted to perform such logging. Similarly, ground fault detection circuit **32** could be replaced by a conventional ground fault detection circuit, as for example available from IPC

Resistors under model number MGFR 20-ZB, or the like. In a further alternate embodiment, the ground fault detection circuit could optionally include a circuit breaker in series with conductors **34a/34b** to limit the flow of current to any car having a detected ground fault.

[0030] Of course, the above described embodiments, are intended to be illustrative only and in no way limiting. The described embodiments of carrying out the invention, are susceptible to many modifications of form, arrangement of parts, details and order of operation. The invention, rather, is intended to encompass all such modification within its scope, as defined by the claims.